CQA REPORT

CONSTRUCTION QUALITY ASSURANCE REPORT

Disposal Modules 4.3 and 6.2 Liner System

Recology Hay Road Facility

Revision 0

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1.0 INTRODUCTION

1.1 Overview

Recology Hay Road (RHR) owns and operates the Recology Hay Road Facility. Disposal Modules (DM) 4.3 and 6.2 are Class II waste management units that were constructed in accordance with the project technical specifications, construction drawings, and construction quality assurance (CQA) plan. This construction was also completed in accordance with Waste Discharge Requirements (WDRs) Order No. R5-2008-0188, and the applicable requirements of federal Subtitle D regulations and Title 27 of the California Code of Regulations (CCR). The project site location is shown on Figure 1. Golder Associates Inc. (Golder) provided the CQA services for the construction of this base liner system.

This CQA Report documents construction activities and CQA monitoring and testing for construction of the DM-4.3/6.2 subgrade and base liner system during the summer of 2013.

1.2 Project Description

The combined DM-4.3/DM-6.2 measures approximately 9.9 acres in plan area and is located immediately south of DM-6.1. Individually, DM-4.3 measures approximately 4.9-acres and DM-6.2 measures approximately 5.0-acres. DM-4.3 drains to a sump located on the eastern edge of DM-4.1. DM-6.2 drains to a sump located at the northern end of DM-6.1. Figure 2 shows the site plan and relative location of DM-4.3/6.2. Figure 3 shows the grading plan for the DM-4.3/6.2 liner system.

The DM-6.2 base grades slope at 2 percent toward three leachate collection pipes oriented generally in a north-south direction. The DM-4.3 base grades slope at 2 percent towards two leachate collection pipes oriented generally in the east-west direction. These leachate collection pipes slope at 1 percent toward the northern and eastern perimeter, respectively. The east side of the DM-4.3/6.2 base liner system ties into the existing DM-4.2 and 5.2 base liner systems. The north side of DM-6.2 base liner system ties into the existing DM-6.1 base liner system.

The base liner system is a double-composite liner system as described in the Liner Performance Demonstration Report prepared by Golder (April 15, 2003). The base liner containment system is comprised of the following components (from the bottom up):

- General earthfill (the upper 6-inches comprised of fine-grained soils)
- Secondary 60-mil HPDE geomembrane (double-sided textured)
- Leak detection geocomposite
- 2.5-foot primary compacted clay liner ($k \leq 1 \times 10^{-7}$ cm/s, excluding the lower 6-inches)
- Primary 60-mil HPDE geomembrane (single-sided textured)

- 6-inch thick leachate collection and removal system (LCRS) gravel
- 8-oz. geotextile filter layer
- 1-foot thick operations layer

1.3 Contractors

Construction of the DM-4.3/6.2 base liner system was performed by BostonPacific Inc. (BPI) of Dixon, who acted as the general contractor. The installation subcontractor for the geosynthetic liner system was D&E Construction (D&E) of Visalia, California. The 60-mil HDPE primary geomembrane, 60-mil HDPE secondary geomembrane, geocomposite, and 8-oz geotextile material were provided by GSE, located in Houston, Texas. Surveying for the project was completed by Bellecci & Associates, Inc. under subcontract to BPI.

1.4 Construction Quality Assurance

Golder provided CQA monitoring and testing services for the DM-4.3/6.2 base liner construction project according to the CQA Plan approved by the Central Valley Regional Water Quality Control Board (CVRWQCB). The CQA services consisted of observing, testing, and documenting the construction activities to verify compliance with the construction drawings and specifications. The CQA services included, but were not limited to:

- Review of manufacturer's submittals and conformance testing of the geosynthetic products
- Testing of the construction materials used for the general earthfill, low-permeability soil liner, LCRS gravel, and operations soil
- Observation of the geosynthetics installation and testing of the field seams for the HDPE geomembrane
- Observation of the LCRS collection piping installation

During the subgrade and base liner system construction, Mr. Ken Brown, P.E. provided the lead CQA observation and testing in the field for the base liner system for DM-4.3/6.2 from April 16, 2013 until August 29, 2012. Mr. Jesse Smith and Mr. Pete Bowers, P.E. provided technician support throughout the 2013 DM-4.3/6.2 base liner system project. Ms. Amy Ha, P.E., provided project supervision and was the CQA Engineer-of-Record.

Photographs documenting key components and activities of the construction process were taken on a regular basis. Selected photographs are included in Appendix A.

Daily field monitoring reports were prepared throughout the construction to document the construction and the CQA observation and testing. The field monitoring reports are included in Appendix B.

1.5 Project Documents

All work for the DM-4.3/6.2 base liner system was performed according to the construction drawings and specifications, which are listed below:

- "Construction Drawings, Disposal Module 4.3 & 6.2, Base Liner Design, Recology Hay Road, Solano County, California," prepared by Golder Associates, dated February 2013
- "Construction Specifications, Disposal Module 4.3 & 6.2, Base Liner Design, Recology Hay Road, Vacaville, California," prepared by Golder Associates, dated January 2013
- "Construction Quality Assurance Plan, Disposal Modules 4.3 and 6.2 Base Liner System, Recology Hay Road Facility, Vacaville, California," prepared by Golder Associates, dated January 2013

1.6 Design Changes and Clarifications

Generally during the course a project, design changes and/or clarifications are processed to facilitate the construction process. The following minor design clarifications were needed during the construction of the DM-4.3/6.2 base liner system:

1. Compaction Window for Soil Liner as discussed in Section 3.2
2. Gravel Gradation to allow slightly higher fraction finer than the No. 4 Sieve provided the gravel met the permeability requirements
3. Geotextile Tie-In to allow heat bonding of seams

1.7 Surveying and Preparation of Record Drawings

Bellecci & Associates, Inc., under the supervision of Charles N. Capp, registered land surveyor, performed surveying for the project. Bellecci & Associates, Inc. established control points in the field for use by the contractor. Based on the control points, BPI performed construction grade control using Global Positioning System (GPS) technology. Bellecci & Associates, Inc. completed as-built surveys using the 50-foot grid system presented in the Drawings to determine the as-built elevations of each layer. As-built surveys were completed for the following:

- Top of general earthfill (subgrade)
- Top of low-permeability soil liner
- Top of LCRS gravel
- Top of operations soil

The record drawings prepared by Bellecci & Associates, Inc. are presented in Appendix C.

The location of each HDPE geomembrane panel was determined in the field using a measuring wheel. The record drawings for the HDPE geomembrane panels (primary and secondary layers) were prepared by D&E and reviewed by Golder. These drawings are also presented in Appendix C.

2.0 SUBGRADE PREPARATION AND GENERAL EARTHFILL

The subgrade preparation required for the construction of the DM-4.3/6.2 base liner system consisted of placing compacted general earthfill to the lines, grades and tolerances specified in the construction drawings. Approximately 160,000 cubic yards (cy) of general earthfill was excavated from the site borrow area and then used as general fill for base grades associated with DM-4.3/6.2. The borrow soils predominately consist of clays and silty clays with occurrences of interbedded clayey sand and occasional pockets of fine- to medium-grained sand.

General earthfill placement began on April 16, 2013. The general earthfill was excavated using a Komatsu PC600LC excavator and hauled to DM-4.3/6.2 using articulating trucks including CAT 735, CAT 350E, and 3-CAT 7408 models. Excavation occurred from the soil borrow area located west of the landfill. BPI excavated dewatering trenches in the borrow area following mobilization in April. In general, the soils were excavated at relatively high moisture contents. Moisture conditioning to dry the soils was completed by discing and wind-rowing the soils in thin lifts and performing compaction the following day. Compaction was performed with CAT 815 and CAT 825 compactors. Final grading was completed using a CAT 163H motor grader. A CAT 825 smooth drum vibratory compactor was used to provide the finish surface for the general earthfill. General earthfill placement for the cell subgrade was completed on June 18, 2013.

CQA procedures for the general earthfill consisted of laboratory testing, monitoring placement methods, moisture conditioning, and determination of compaction using nuclear moisture-density testing methods (ASTM D6938). Laboratory testing of the general earthfill material consisted of Proctor compaction tests (ASTM D1557). Appendix D.1 includes the proctor compaction curves for the general earthfill. A summary of the in-situ density testing is presented in Appendix D.2. A total of 332 compaction tests were performed on an estimated 160,000 cy of soil, resulting in a testing frequency of 481 cy/test. This frequency exceeds the required testing frequency identified in the CQA Plan (1 test per 500 cy). The results of the compaction tests each measured a relative compaction of at least 90 percent. The project specifications required a minimum relative compaction of 90 percent in accordance with ASTM D 1557. Therefore, the compaction test results indicated that the general earthfill was placed and compacted in accordance with the project specifications.

The general earthfill material was compacted to provide a firm and unyielding surface to support the liner system. At the completion of the placement and compaction, the exposed soils at the surface were systematically examined by Golder's CQA Technician to verify that the upper surface of the liner subgrade was exceptable for HDPE liner placement and consisted of clay, silty clay, and/or sandy clay classified as CH, CL, or SC in accordance with the Unified Soil Classification System.

A topographic survey was prepared by Bellecci & Associates, Inc. Point data was also submitted and verified by Golder for compliance with the design grading tolerances. The survey elevations are indicated on the as-built topographic drawing, presented in Appendix C.

3.0 LOW-PERMEABILITY SOIL LINER

3.1 General

The low-permeability soil material was obtained from on-site clay soils contained in the borrow area located west of the landfill. Golder completed a borrow investigation on November 27, 2012. Soil obtained for placement as low-permeability soil liner was obtained from the horizontal and vertical range of the area investigated. Laboratory tests were performed on selected samples to verify suitability of the on-site soil for use as a low-permeability soil liner material. A test pad and field infiltration test was completed during the 2012 construction of DM-6.1 to verify that the proposed equipment and handling procedures would result in low-permeability soil liner that met the compaction and permeability requirements. A test pad and field infiltration test is not required during the DM4.3/6.2 construction because the low-permeability soil liner material was obtained from the same borrow source location and the soil properties from the samples for the borrow investigation exhibited similar soil properties.

3.2 Low-Permeability Soil Liner Construction

The low-permeability soil liner is a 2.5-foot thick layer of compacted low-permeability soil in which the upper two feet is required to have a permeability of 1×10^{-7} cm/s or less. The soils used to construct this layer were obtained from the borrow area located west of the landfill. The low-permeability soil liner was constructed from June 24, 2013 through July 16, 2013.

The low-permeability soil consisted of a brown, silty clay classified as a CH or CL in accordance with the Uniform Soil Classification Systems (USCS) per ASTM D2487. The soils exhibited an average Liquid Limit (LL) of 41, an average Plastic Index (PI) of 28 and average fines content (minus No. 200 sieve) of 80 percent. These values are very similar to those used in the previous DM-6.1 liner construction.

The low-permeability soil liner was constructed directly on top of the leak detection geocomposite. The first lift measured 12-inches in thickness to prevent construction damage to the underlying geosynthetic layers. The lower 6-inches of the first lift was placed as a foundation layer for the overlying 2-feet of low-permeability soil liner. Although the foundation layer was not tested for compaction or permeability, it was tested for Atterberg Limits and grain-size properties to establish that the material is the same as that used for the soil liner. The quantity of foundation layer material was estimated to be 7,920 cy and the low-permeability soil liner was estimated to be 31,680 cy, for a combined total of 39,600 cy.

The low-permeability soil liner material was excavated from the borrow area at moisture contents generally within the specified compaction window. Moisture was maintained in the placement area using a water truck or conditioned as necessary. The soil was excavated with a Kamatsu PC600LC excavator and hauled to DM-4.3/6.2 using articulating dump trucks. Following the initial 12-in lift, the soils were placed in 6 to 8-inch thick loose lifts and compacted with a Caterpillar 825 pad-foot compactor. Final grading was completed using a Caterpillar 140G grader. A Caterpillar smooth drum vibratory compactor was used to provide the finish subgrade surface for the low-permeability layer.

The initial specified compaction window for this construction project was the same window used previously for the DM-6.1 base liner construction. The previous compaction window was defined by a minimum moisture content of 17 percent, a minimum relative compaction of 90 percent, and a minimum degree of saturation of 83 percent. This compaction window was based on a typical optimum moisture content of 14% with the intent of having a minimum moisture content of plus 3% above optimum.

During initial low-permeability soil placement, the soil would not compact at a moisture of 17% in an area of approximately 750 feet by 100 feet in the southwest corner of DM-4.3/6.2. Golder personnel observed the soil pumping when the water content was above 17% indicating that the optimum moisture content for this soil was lower than 14%.

Construction of the low-permeability soil liner was halted until Golder could verify the compaction window for the initial soil placed in the southwest corner of DM-4.3/6.2. The optimum moisture content was determined to be 11.3%, which is at the lower end of the range of moisture contents observed during past construction projects. Two in-situ permeability tests of this material were collected in areas where the moisture content was below 17%. The permeability test results were 8.2×10^{-8} and 2.5×10^{-9} cm/sec, which met the maximum requirement of 1.0×10^{-7} cm/sec. Based on the additional laboratory test results, the soil material met the requirements for the low-permeability soil liner.

As allowed by the project specifications, Golder issued a revised compaction window for soil material that was excavated from the borrow area with optimum moisture contents less than 14%. The compaction window was modified to a minimum of 90 percent relative compaction at a moisture content of at least 3 percent above optimum, which is consistent with past construction practices. Additional permeability testing results all met the minimum requirement of 1.0×10^{-7} cm/sec.

CQA procedures consisted of monitoring placement, moisture conditioning, and measurement of in-situ moisture-density using a nuclear density gauge (ASTM D6938) and the drive cylinder method (ASTM D2937). Golder performed 158 nuclear moisture-density tests, resulting in a testing frequency of one test per 201 cy. This frequency meets the CQA Plan requirements (maximum 250 cy/test). In addition, samples of the low-permeability soils were obtained for laboratory testing including moisture content (ASTM D2216), particle-size distribution (ASTM D1140), Atterberg Limits (ASTM D4318), modified Proctor density (ASTM D1557), and hydraulic conductivity (ASTM D5084). The results of this testing are summarized in Appendix E.1. A summary of the in-situ moisture density testing is presented in Appendix E.2. CQA testing frequencies are summarized in Table 1.

TABLE 1
LOW-PERMEABILITY SOIL LINER CQA TESTING FREQUENCIES

Parameter	Test Method	Minimum Specified Frequency	Number of Tests	Actual Construction Frequency
Moisture-Density	D1557	1 Per 5,000 or change in material	8	1 Per 4,950 CY
Nuclear Moisture-Density	D6938	1 Per 250 CY	158	1 Per 201 CY
Sand Cone, or Drive Cylinder	D1556, D2937	1 Per 20 Nuclear Density Tests	9	1 Per 18 tests
Particle Size	D422/D1140	1 Per 1,500 CY	28	1 Per 1,415 CY
Atterberg Limits	D4318	1 Per 1,500 CY	28	1 Per 1,415 CY
Soil Classification	D2487/2488	1 Per 1,500 CY	28	1 Per 1,415 CY
Laboratory Hydraulic Conductivity on Field Collected Sample	D5084 at 15 psi	1 Per 1,500 CY	23	1 Per 1,378 CY

On average, the soils were compacted to a dry density of 115.9 pcf and a moisture content of 16.8%.

Permeability samples were obtained in 3-inch diameter Shelby tubes and transported to Sierra Testing Laboratories in El Dorado Hills, California. The results of the permeability testing indicated measured permeabilities ranged from 2.5×10^{-9} cm/s to 9.5×10^{-8} cm/s with an average of 5.9×10^{-8} cm/s.

The top of the primary low-permeability soil liner was surveyed to verify that the design thickness and grades were achieved. The as-built plan is included in Appendix C.

The results of the CQA observations, field and laboratory testing, and surveying indicate that the primary low-permeability soil liner material was placed in compliance with the project specifications.

4.0 LCRS GRAVEL

The leachate collection and recovery system (LCRS) consists of a 0.5-foot thick layer of 3/8-inch pea gravel spread across the floor of the disposal modules over the 60-mil HDPE primary geomembrane. Additionally, LCRS collection pipes were installed on the floor at the locations shown on the Drawings. BPI began welding LCRS collection pipe on July 25, 2013 and placed LCRS gravel between July 26, 2013 and August 16, 2013. HDPE piping materials were obtained from Forrer Supply.

The LCRS gravel was supplied by Cemex located in Madison, California. Approximately 8,000 cy of gravel was hauled to the site in transfer dump trucks. Placement began at the north end of DM-6.2 and was placed southward. Placement was performed by pushing out gravel in 3 to 5 foot thick "roads" with a D8N dozer from the leading edge of operations layer. The roads were placed above the LCRS collection pipe then spread into a 6-inch thick lift. BPI spread and graded the LCRS gravel using a Caterpillar D6M low-ground pressure (LGP) dozer operating on a base of approximately 6-inches of gravel. The dozer used global positioning system (GPS) guided survey equipment to provide grade control. As segments of the LCRS gravel layer were completed, 8 oz/sy nonwoven geotextile was deployed over the gravel. Water was then sprayed over the gravel as the LCRS layer was covered with operations layer materials.

Samples were obtained from the gravel that was delivered to the site. The samples were tested for grain-size (ASTM D422), fractured faces (ASTM D5821), and permeability (ASTM D2434). The measured permeability exceeded the minimum requirement of 1.0 cm/s and averaged 2.4 cm/s. The percentage of particles 3/8-inch or larger with more than one fractured face was measured between 4 and 8 percent, which was less than the 25 percent maximum value.

The gravel generally met the maximum particle-size requirement (100 percent less than 1/2-inch minus, 100 to 85 percent less than the 3/8-inch sieve, 0 to 30 percent less than the U.S. No. 4 sieve, and 0 to 2 percent less than the U.S. No. 200 sieve). The fraction finer than the No. 4 sieve slightly exceeded the specification value of 0 – 30 percent in two of the seven gravel samples tested. LCRS-2 and LCRS-5 contained 31% and 33% of material finer than the No. 4 sieve. The corresponding the permeability values for LCRS-2 and LCRS-5 were both greater than the minimum permeability requirement of 1.0 cm/sec. The gravel material was accepted with the slight deviation in gradation specification because the gravel met the fractured faces and permeability requirements.

The CQA testing frequencies met or exceeded the CQA plan requirements and are detailed in Table 2.

TABLE 2
LCRS GRAVEL CQA TESTING FREQUENCIES

Parameter	Test Method	Minimum Specified Frequency	Number of Tests	Actual Construction Frequency
Sieve Analysis	D422/C136	1 Test Per 1,500 CY	7	1 Per 1,143 CY
Visual Classification	D2488	Continuous Observation		Continuous Observation
Hydraulic Conductivity	D2434	1 Test Per 3,000 CY	4	1 Per 2,000 CY
Fractured Faces (Gravel Fraction Only)	D5821	1 Per Source[1] 1 Test Per 1,500 CY	7	1 Per 1,143 CY

Based on the survey data submitted by BPI, the thickness of the LCRS gravel averaged 0.51 feet thick and was within design tolerances.

Five 4-inch diameter perforated HDPE LCRS pipes were installed within the DM-4.3/6.2 LCRS gravel. Two of the pipes were installed in the general east-west direction and tie into to the DM-4.2 LCRS system. Three of the pipes were installed in the north-south direction and tie into the existing DM-6.1 LCRS system.

Two 2-inch diameter HDPE injection pipes were installed within the DM-4.3/6.2 LCRS gravel. The permanent injection pipe previously installed in DM-6.1 was extended into DM-6.2 and capped approximately 150 feet north of DM-4.3. This pipe was perforated along the southern 50 feet. A temporary injection pipe was also installed from the south edge of DM-4.3 extending approximately 105 feet northward and perforated along the northern 50 feet. The temporary injection pipe will be abandoned following the future construction of DM-7. The purpose of the injection pipes is to allow water to be injected annually into the LCRS to verify adequate performance.

5.0 GEOSYNTHETICS

5.1 Review of Submittals and Material Conformance Testing

Geosynthetics utilized for the DM-4.3/6.2 base liner construction project consisted of the following components:

- 60-mil double-sided textured HDPE geomembrane liner (black both sides)
- 60-mil single-sided textured HDPE geomembrane liner (white/black)
- Geocomposite drainage layer
- 8-oz. geotextile filter layer

Golder performed conformance testing of the HDPE geomembrane, geocomposite, and geotextile materials and reviewed the manufacturer's quality control certificates prior to use of the materials on the project. Copies of the manufacturer's quality control documentation are included in Appendix G as follows:

- Appendix G.1 – HDPE Geomembrane
- Appendix G.2 – Geocomposite
- Appendix G.3 – Geotextile

Conformance samples were obtained from the manufacturing plant or upon delivery to the site. Golder staff selected the rolls of materials for conformance sampling. Samples were shipped to Golder's Geosynthetics Laboratory in Atlanta, Georgia for conformance testing. Copies of the conformance tests results and test summaries are presented in Appendix H as follows:

- Appendix H.1 – HDPE Geomembrane
- Appendix H.2 – Geocomposite
- Appendix H.3 – Geotextile

Golder's technicians performed an inventory of the on-site materials to confirm that the roll numbers for each of the geosynthetic components correlated to the manufacturer's submittals and shipping manifests. Copies of the material inventories prepared by Golder are presented in Appendix I as follows:

- Appendix I.1 – HDPE Geomembrane
- Appendix I.2 – Geocomposite
- Appendix I.3 – Geotextile

The frequencies of conformance testing met or exceeded minimum frequencies specified in the CQA Plan, which are summarized below:

- HDPE Secondary Geomembrane: 6 tests for 422,000 square feet (min. required frequency of 1 test/150,000 sf required)
- HDPE Primary Geomembrane: 5 tests for 439,000 square feet (min. required frequency of 1 test/150,000 sf required)

- Geocomposite: 2 tests for 426,000 square feet (min. of 1 test/250,000 sf required)
- Geotextile: 4 tests for 430,000 square feet (min. of 1 test/150,000 sf required)

In addition, direct shear testing was completed between the geomembrane/geocomposite (GM/GC) and geomembrane/low-permeability soil liner (GM/Soil) interfaces. The results of these tests are included in Appendix H.1. Based upon the manufacturer's quality control documentation and the results of the conformance tests, all of the geosynthetic materials that were installed were accepted.

5.2 Geomembrane

A 60-mil double-sided textured, HDPE, geomembrane liner (colored black on both sides) was installed as the DM-4.3/6.2 secondary liner system to the limits identified on the design drawings. A 60-mil single-sided textured, HDPE geomembrane liner (colored white on the smooth side) was installed as the DM-4.3/6.2 primary liner system with the textured side down. The HDPE geomembrane was deployed following the completion of the grading and surveying of the general fill and low-permeability soil liner. Prior to geomembrane deployment, the subgrade was inspected to verify that it was suitable to support the geomembrane liners. Copies of the subgrade certificates are included in Appendix J.1.

The secondary HDPE geomembrane deployment began on June 17, 2013 and was completed on July 9, 2013. The primary HDPE geomembrane deployment began on June 22, 2013 and was completed on July 26, 2013.

The 60-mil HDPE geomembrane was deployed using an all-terrain forklift and a spreader bar. Each roll measured 22.5 feet wide by 490 feet long for the double-sided textured, and 22.5 feet wide by 420 feet long for the single-sided textured. A record of the deployment logs is presented in Appendix J.2. The record drawings representing the location of the liner panels were prepared by D&E and reviewed by Golder. These as-built record panel drawings are presented in Appendix C.

Golder observed the deployment and seaming of the 60-mil HDPE geomembrane installed by D&E. Prior to seaming operations, D&E performed trial seams at the beginning of each shift, or upon re-starting the machine after lunch breaks, to demonstrate the adequacy of the seaming apparatus and the operator's procedures. Each trial seam was sampled and tested by D&E for peel adhesion and bonded seam strength. These trial seaming procedures were observed and documented by Golder personnel. Upon observation of successful trial welds, the operators were given approval to begin seaming. Archive samples of trial welds were collected. Copies of the trial seam logs are presented in Appendix J.3.

In general, the split wedge fusion method was used for seaming of the HDPE geomembrane liner and ran concurrently with deployment of the geomembrane. This method of fusion seaming produces an air channel that is air-pressure tested for leaks. The extrusion seaming method was utilized for patches, and repairs. Both fusion and extrusion seaming methods were utilized for the tie-in to the DM-6.1, DM-5.2, and DM-4.2 liner systems. Golder observed and documented the welding of all seams, patches, or other repairs either during or shortly after completion. Copies of the seaming logs are presented in Appendix J.4.

All non-destructive seam continuity testing was performed by D&E and observed by Golder. Non-destructive seam testing was required on all field seams and on all repairs including the destructive test sample patches. Two methods of non-destructive testing were used for this project:

- Vacuum testing on extrusion welds
- Air pressure testing on split wedge fusion welds

A vacuum box is a rigid-wall box with a clear Plexiglas top and a neoprene gasket around the bottom of the box forming a seal between the box and the HDPE liner. Vacuum testing procedures consist of the following:

- Applying a soapy water solution to the seam
- Applying a vacuum of approximately 10 inches of mercury (5 psi) to the inside of the box for 10 seconds
- Observing the weld for expanding bubbles which would indicate a discontinuity in the weld

Air pressure testing procedures consist of the following:

- Sealing off the air channel between the inside and outside tracks of the fusion weld at each end of the seam
- Inserting a needle with an attached pressure gauge into the air channel
- Inflating the air channel to approximately 30 psi using a hand pump or a small pressurized air tank
- Observing the pressure gauge over a five-minute period (a pressure drop of more than 2 psi during this period would indicate a possible discontinuity in the seam)
- Puncturing of the seam air channel at the far end of the seam to allow release of the pressurized air to verify testing was for the entire seam length

Any leaks or discontinuities detected in the seams or welds were marked and subsequently repaired in accordance with the specifications. As repairs were made to the geomembrane, Golder documented the location and verified that all repairs were vacuum box tested. Documentation summarizing the observation of the non-destructive seam testing is presented in Appendix J.5.

Repairs consisted of small patches, extrusion beads, or welds. Repairs were made along the intersection of panels, at cuts in the liner made for air pressure testing of the fusion welded seams, or for defects due to holes or blemishes observed in the liner from installation damage. The repairs were marked in the field by Golder and were then subsequently repaired by D&E. A summary of the Repair Logs is presented in Appendix J.6.

A summary of the destructive test results is presented in Appendix J.7. In the destructive test, ten (10) one-inch wide test coupons are cut from each destructive test sample. Five of the coupons are tested for adhesion (peel test mode, both inside and outside track for fusion seams) and five coupons are tested for bonded seam strength (shear test mode) in accordance with ASTM D6392. Breaks are analyzed for Film-Tear-Bond (FTB) or non-FTB in accordance with ASTM D6392.

Destructive test samples were obtained from the HDPE geomembrane seams at a maximum frequency of one sample per 500 lineal feet. A total of 92 destructive test samples were tested, resulting in an overall testing frequency of approximately one test per 456 feet of seam.

Test results indicated that all of the destructive seam tests met the project specifications.

5.3 Geocomposite

A geocomposite drainage layer was installed directly over the secondary 60-mil HDPE geomembrane liner as the leak detection layer on the floor of the landfill

The geonet component of the geocomposite layers was installed with a minimum 4-inch overlap between adjacent panel edges and fastened using plastic ties at a maximum spacing of 5 feet on panel edges and 1-foot across butt-seams. The upper geotextile component was sewn continuously along seams in accordance with the project specifications.

Based on observations made by Golder, the geocomposite layer was installed in accordance with the project specifications.

5.4 Geotextile

An 8-oz/sy non-woven geotextile was installed as a filter layer above the LCRS gravel. D&E installed the geotextile above the LCRS gravel immediately following the placement and grading of the LCRS gravel layer.

The geotextile panels were seamed together with sewing equipment using polymeric thread. Golder verified that adequate seaming was performed and observed the general condition of the geotextile.

Operations soil that was adhered to the upper surface of the exposed existing geotextile along the edges of existing disposal modules DM-6.1, DM-5.2, and DM-4.2 made sewing the existing geotextile to the DM-4.3/6.2 geotextile difficult. Along the tie-in from DM-4.3/6.2 to the existing disposal modules, the geotextile was heat bonded along the seams with a minimum 2-foot overlap.

6.0 OPERATIONS SOILS

The operations layer soils were placed upon completion of the LCRS gravel, geotextile filter deployment, and LCRS geocomposite drainage layer installation. The operations soil layer consisted of native borrow soils and an admixture of biosolids and soil, which were placed in specific areas delineated on the construction drawings. BPI used a Kamatsu PC600LC excavator with 10 wheeled dump trucks to deliver the operations soils from stockpiles and spread the operations layer soils with a Caterpillar D6M LGP dozer outfitted with a GPS grade control system. To address odor control issues, a thin layer (approximately 0.2 feet) of onsite borrow soil was spread over the admixed biosolid material. A dozer was used to finish-grade the final operations soil layer surface.

Golder monitored the operations layer soil materials and the soil thickness by observing placement operations and thickness throughout the placement activities. Particle-size distribution tests and moisture content test results completed on the operations soil layer are included in Appendix M.

The placement of the operations layer was started on July 27, 2013. The operations layer and landfill composite liner system was substantially completed on August 19, 2013 with the exception of the outer edges of the liner system. The outer edges of the HDPE geomembrane were left exposed during the completion of the electrical leak location survey as discussed in Section 7.0. Following the completion of the electrical leak location surveys, the contractor finished placing the remaining operations soil layer materials between August 26, 2013 and August 28, 2013.

During placement of the operations soil layer, the geotextile was ripped in two places by the equipment. At both of these locations, the operations soil was removed to expose the geotextile and the underlying gravel was removed to verify that the primary liner was not damaged. The liner was not damaged at either location. The gravel was replaced and a geotextile patch was installed with a minimum overlap of 2 feet. Operations soil was placed over the geotextile patches to the design grades.

The as-built plan prepared by Bellecci & Associates, Inc. is presented in Appendix C. Review of the as-built information indicates that the operations layer was constructed in general accordance with the design grades.

7.0 LEAK LOCATION SURVEY

An electrical leak location survey (ELLS) was performed in accordance with ASTM D7007 at the completion of the operations soil layer placement. The ELLS was performed by Leak Location Services, Inc. (LLSI) under subcontract to Golder to determine if holes or defects existed in the primary 60-mil HDPE geomembrane liner following completion of the LCRS gravel and operations layer. Leak Location Services, Inc. performed the ELLS from August 21, 2013 through August 23, 2013.

At the beginning of each survey, an artificial leak test was completed by placing a 1/4-inch diameter electrode at the top of the primary geomembrane to verify that the overlying gravels and operations soil could adequately conduct an electrical current. The results of the artificial leak test indicated that overlying materials were adequately conducting an electrical current.

The results of the survey detected one defect in the primary HDPE geomembrane in DM-4.3/6.2. The defect was located in the south east corner of the cell approximately 85 feet north from the south edge of the cell and approximately 100 feet west from the east edge of the cell. The defect and the two small perforations in the north and south edges of the liner system, where the DC voltage wires for the ELLS electrodes penetrated the geomembrane, were repaired on August 26, 2013. D&E completed a trial weld prior to the start of the repairs. The holes were extrusion welded and then vacuum tested. Golder was on-site, observed, and recorded the repairs. Appendix L includes a report from Leak Location Services, Inc. that describes the methodology and results of the survey.

8.0 LEAK DETECTION MONITORING CONSIDERATIONS

Water will enter the leak detection system as the liner system is loaded with refuse and the primary low-permeability soil layer consolidates. This is a common occurrence in double-liner systems containing compacted clay liners. This consolidation water is not indicative of a leak in the primary liner system.

The consolidation will generally increase as the refuse loading increases and will significantly decrease after the refuse loading remains constant. Therefore, the occurrence of consolidation water should correlate to increasing refuse loading in the waste cell.

9.0 SUMMARY AND CONCLUSIONS

Golder provided CQA and testing services during construction of the Disposal Modules 4.3 and 6.2 base liner systems at the Recology Hay Road facility in Vacaville, California. Construction of the base liner system covered by this CQA Report occurred between April 16, 2013 and August 29, 2013.

The CQA services provided for this project consisted of observing, testing, and documenting the construction activities to verify compliance with the project design plans and specifications. The CQA activities described in this report include the following:

1. Observation and testing the general earthfill soils beneath the liner systems
2. Observation of the liner subgrade
3. Observation and testing of the low-permeability soil liner
4. Observation and testing of the geomembrane, geocomposite, and geotextile materials
5. Observation and testing of the LCRS gravel and operations soils construction
6. Completion of an ELLS
7. Review and verification of the containment system as-built documents

Based on the daily communications with CQA technicians, on observations made during site visits, and on review of the laboratory and field test results and documentation provided and certified by others, Golder hereby states that, in our professional opinion, the containment system for the DM-4.3/6.2 base liner system at the Recology Hay Road Facility was constructed in accordance with the project plans and specifications, WDR Order No. R5-2008-0188, and the applicable requirements of the California Code of Regulations, Title 27 pertaining to a Class II Landfill.

Respectfully submitted,

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10.0 REFERENCES

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